

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference H 1611 PCT		FOR FURTHER ACTION	
International application No. PCT/EP2004/003415	International filing date (day/month/year) 31.03.2004	Priority date (day/month/year) 11.04.2003	
International Patent Classification (IPC) or national classification and IPC A61B5/117, A61B3/00			
Applicant BAUSCH & LOMB INC. ET AL.			

1. This report is the International preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
 - a. ☒ sent to the applicant and to the International Bureau a total of 5 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 21.10.2004	Date of completion of this report 29.07.2005
Name and mailing address of the International preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Neef, T Telephone No. +31 70 340-4653 

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/003415

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-12 as originally filed

Claims, Numbers

1-27 received on 19.07.2005 with letter of 18.07.2005

Drawings, Sheets

1/2, 2/2 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/003415

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-27
	No: Claims	none
Inventive step (IS)	Yes: Claims	1-27
	No: Claims	none
Industrial applicability (IA)	Yes: Claims	1-27
	No: Claims	none

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1 Reference is made to the following documents:

- D1: WO 01/28476 A (HOHLA KRISTIAN ; NEUHANN THOMAS (DE); TECHNOLAS GMBH OPHTHALMOLOGISC ()) 26 April 2001 (2001-04-26)
D2: US-A-5 291 560 (DAUGMAN JOHN G) 1 March 1994 (1994-03-01)

2 **Most relevant state of the art**

The document D1 is regarded as being the closest prior art to the subject-matter of independent apparatus claims 1, 8, 17 and the corresponding method claims 25- 27, and shows:

- a **system and method for acquiring eye data** with a diagnostic unit for producing diagnostic data (page 3, line 5,- page 4, line 2) and an iris recognition unit (page 25, last paragraph- page 26, paragraph 2; page 16, paragraph 2- page 17, line 17) for acquiring an iris code of the eye (page 6, lines 6- page 17, line 17; page 14, paragraph 3, page 8, lines 4-10) with an image pick-up unit (110, 154).
- a **system and method for aligning and tracking** of an eye of a patient with reference to an ophthalmic unit performing diagnosis (100) and/or treatment of the eye (102) (figures 1, 2a-c, 12; page 3, line 5- page 5, line 2), means for providing a previously acquired iris code of an eye (114, 120) of a patient (page 6, lines 6- 14); with an iris recognition unit for acquiring an iris code of the eye (see paragraph 2 above; page 14, paragraph 3, page 8, lines 4-10); and with a comparator for comparing the present iris code with a previously stored iris code and providing a comparison result, wherein the diagnosis/treatment of the eye is performed when the present iris code is identified/validated with the previous one (page 25, last paragraph - page 26, first paragraph; page 18, paragraph 2; page 20, paragraph 2).
- an **iris recognition unit and method** with an image-pick up unit (110, 154) for acquiring an image of an eye (120), an image processing unit (104) determining iris information at a plurality of positions of the image of the eye and a unit for generating an iris code based on the iris information at a plurality of positions of the imaged eye (page 6, lines 6- page 17, line 17; page 14, paragraph 3, page 8, lines 4-10).

3 Difference with the state of the art

The subject-matter of the independent claims 1, 8, 17, 25- 27 differs from the system and recognition unit of D1 in that the iris code is based on the comparison of grey values of at least two individual pixels at or in the neighbourhood of a plurality of positions.

4 The subject-matter of claims 1, 8, 17, 25- 27 is therefore new (Article 33(2) PCT).

5 Inventive step

The solution to this problem proposed in claims 1,8,17, 25- 27 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The **problem to be solved** by the present invention may be regarded as the generation of an iris code (data representing the iris information/image).

In the case of the invention, this is done by taking into account additional information of the area surrounding the positions/pixel, through the comparison of grey values with the neighbouring pixels. Thereby, eliminating the need for correcting for light reflections or other artefacts from the eye image (as e.g. done in D2), as the iris code is defined on the relation between the point of interest/position and it's neighbouring pixels.

D1 and other documents cited in the International Search Report generate as well an iris code (iris image data) to represent the image of the eye, however none of the documents suggests to create a code from the comparison with neighbouring pixels, nor is such a comparison obvious.

6 Dependent claims

Claims 2- 7, 9- 16, 18-24 are dependent on claims 1, 8, 17 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

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18. Juli 2005

CLAIMS

1. System for acquiring data of an eye of a patient comprising a diagnosis unit for acquiring diagnosis data of the eye and an iris recognition unit further comprising an image pick-up unit for acquiring an image of the eye and comparing means for acquiring an iris code of the eye by comparing grey values of at least two individual pixels at or in the neighbourhood of a plurality of positions.
2. The system of claim 1, further comprising processing means for determining coordinates of a pupil center of the eye.
3. System of claim 1 or 2, wherein the diagnosis data and/or the iris code and/or the center of the pupil of the eye are related to a common coordinate system.
4. System of any of claims 1 to 3, further comprising storage means for storing at least two of the following data, the diagnosis data, the iris code, the coordinates of the pupil center when the pupil is not dilated and the coordinates of the pupil center when the pupil is dilated, a data designating a patient and a respective eye and data regarding the acquisition of data.
5. System of any of claims 1 to 4, wherein the diagnosis unit comprises an aberrometer which preferably acquires diagnosis data of the eye of a patient who is sitting up right, preferably a Zywave aberrometer.

6. System of any of claims 1 to 5 comprising an image pick-up unit, preferably a video camera which is preferably working in the infrared region.
7. System of any of claims 4 to 6, wherein the storage means comprises means for reading and writing data on a data carrier, preferably a chip card.
8. System for aligning and for tracking of an eye of a patient with reference to an ophthalmic unit for performing a diagnosis and/or treatment of the eye comprising means for providing a previously acquired iris code of an eye of a patient, an iris recognition unit further comprising an image pick-up unit for acquiring an image of the eye and comparing means for acquiring an iris code by comparing grey values of at least two individual pixels at or in the neighbourhood of a plurality of positions of the eye under investigation as a present iris code, and a comparator for comparing the present iris code with a previously acquired iris code and providing a comparison result, wherein said ophthalmic unit performs said diagnosis and/or treatment of the eye when said comparison result is greater than an identification determining level.
9. System of claim 8, wherein said comparator comprises means for performing correlation between said present iris code and said previously acquired iris code, wherein said present iris code is related to a first rotational position and said previously acquired iris code is related to a second rotational position, a modification unit for modifying the present iris code and/or the previously acquired iris code such the relative position between the first rotational position and the second rotational position is changed, and a determining unit for determining the highest correlation between said present iris code and said previously acquired iris code being modified over a predetermined range of relative rotation.
10. System of claim 9, wherein the eye under investigation is aligned to the ophthalmic unit by said rotational shift corresponding to the highest correlation between the present iris code and the previously acquired iris code.

11. System of any of claims 8 to 10, further comprising processing means for determining coordinates of a pupil center of the eye under investigation, wherein the present coordinates of the pupil center are used in aligning and tracking the eye with reference to the ophthalmic unit.
12. System of any of claims 8 to 11, wherein the ophthalmic unit comprises a refractive surgery apparatus comprising an excimer laser for correction of refractive defects of the eye.
13. System of claim 12, wherein said refractive surgery system performs the correction of refracting defects based on diagnosis data previously acquired for said eye.
14. System of any of claims 8 to 13, comprising a first image pick-up unit having a high resolution for providing an image of the eye to the iris recognition unit and preferably a second image pick-up unit being preferably faster than said first image pick-up unit for providing images being used for tracking the eye with reference to the ophthalmic unit.
15. System of claim 14, wherein said first and said second image pick-up unit being arranged at an angle to each other such that the respective images taken of the eye matches at a predetermined height position of the eye under investigation.
16. System of claim 15, further comprising control means for performing the diagnosis and/or treatment of the eye by said ophthalmic unit when a match between said images of the first and said second image pick-up units is detected.
17. Iris recognition unit especially for use in a system according to any of claims 1 to 16 comprising
an image pick-up unit for acquiring an image of the eye,
an image processing unit for determining iris information at a plurality of positions of the image of the eye and
a generating unit further comprising comparing means for generating an iris code based on said iris information at said plurality of positions of the image of the eye by comparing grey values of at least two individual pixels at or in the neighbourhood of

said plurality of positions.

18. Iris recognition unit of claim 17 comprising means for determining the iris/pupil border and/or the iris/limbus border, wherein said image processing unit determines the plurality of positions based on the relative position of the iris/pupil border with respect to the iris/limbus border.
19. Iris recognition unit of claim 18, wherein said relative position of said iris/pupil border with respect to said iris/limbus border is calculated based on a deviation of a center point of the iris/pupil border with respect to a center point of the iris/limbus border, and/or the length of a radial line starting from a certain point at the iris/pupil border and ending at a corresponding point at the iris/limbus border.
20. Iris recognition unit of any of claims 17 to 19, wherein said comparing means compares grey values of at least two individual pixels at or in the neighbourhood at each respective position of said plurality of positions.
21. Iris recognition unit of claim 20, wherein said comparing means compares the grey values of pixels present in at least one of the following regions, an inner ring surrounding a particular position, a middle ring, surrounding said inner ring, an outer ring surrounding said middle ring, the region above and below a horizontal axis and the region on the left side and the right hand side of a vertical axis going through said particular position.
22. Iris recognition unit of claim 21, wherein said comparing means compares an average of the grey values of pixels within one of said regions with the average of grey values of pixels within a neighbouring region and provides the binary result for each comparison based on whether the difference of the respective average values is greater or smaller than a threshold value.
23. Iris recognition unit of any of claims 20 to 22, wherein said generating unit receives the comparison results as a set of binary values, preferably six binary values for each particular position and provides said iris code by arranging said sets of binary values in

a predetermined order corresponding to the relative positions used in the image processing unit.

24. Iris recognition unit of claim 23, wherein the iris code comprises said sets of binary values in the form of at least one matrix.
25. Method for acquiring data of an eye of a patient using a system according to any of claims 1 to 7.
26. Method for aligning and/or tracking of an eye with reference to an ophthalmic unit using a system according to any of claims 8 to 16.
27. Method for iris recognition using a system according to any of claims 17 to 23.